Enhancement of NIAR Component HIC Tester for Aircraft Seat Certification

A revised statement of work for CGAR project:
"*Development of Analytical Methods to Predict Crash Impact Responses of General Aviation Aircraft Seat/Occupant Restraint System"*

Principal Investigator:
Hamid Lankarani
Professor of Mechanical Engineering and NIAR Senior Fellow
National Institute for Aviation Research
Wichita State University
Wichita, KS 67260-0091
Phone: (316) 978-6307, Fax: (316) 978-3236
Email: Lankaran@me.twsu.edu

FAA Technical Monitor/Contacts: Allan Abramowitz, Gary Frings, and Stephen Soltis
Participants: NIAR/WSU, FAA TC, FAA CAMI

The objective of the project is to enhance the capability of the NIAR component Head Injury Criteria (*HIC*) tester, developed for bulkhead seating problem, to a wide range of aircraft cabin configurations as well as to the Part 23 General Aviation aircraft seat certification problems. The device shall provide an alternate means of compliance with the HIC requirement without the necessity for consuming a seat or seats during each test. The validated tester can be utilized to evaluate different seat designs and/or test conditions at relatively lower cost and shorter period compared to the conduct of dynamic sled testing of the seat/restraint/ATD system.

A series of twelve full-scale sled tests were conducted using aluminum bulkhead of 0.063 in. thickness. The seat set back distance was varied from 28 in. to 35 in. to get the head impact angle in the range from 27 to 61 degrees. The component tester was validated for the same head impact angles in both mode-I and mode-II configurations. Modifications are being done to the top actuator to avoid the secondary impact of the pendulum arm with the support arm extension.

A series of fifty-six component HIC tests were conducted in mode-I and mode-II configuration to validate the results obtained from the full-scale sled tests. Component *HIC* tests were conducted for different head impact angles corresponding to the angles obtained from sled tests by varying the pivot point setback distance and the results obtained were compared to that obtained from the full-scale sled test for a similar configuration.

During some of the component tests secondary peaks were observed in the acceleration profiles for the low head impact angles. These peaks are appearing due to the rebound impact of the pendulum arm with the support arm extension. As the peaks fall in between the *HIC* window, they affect the results obtained from the component tester causing high *HIC* values. Various options were explored to prevent the secondary impact.

Option 1
Convert the top actuator to double acting with the return stroke powered by nitrogen fed from an accumulator rated for 3000psi.

Option 2

Currently working on this option. Modifications were done to the top actuator so as to make it double acting. Compressed air at 100psi is used from a gas bottle to power the return stroke. This option produces sufficient motive force to retract the piston and is substantially cheaper. Even though the compressed air retracts the piston, the nitrogen trapped on the primary side does not vent quickly enough and remains trapped in the actuator. This compressed nitrogen expands and causes the piston to re-extend.

Option 3

Third option will be to move the attachment point of the support arm extension further up on the support arm. This will avoid the contact of the pendulum arm with the support arm when the pendulums arm bounce back.

Status

Options 2 and 3 are currently being developed. A third valve is being put in between the actuator primary end and the diaphragm valve. So that when the return stroke is fired the trapped nitrogen on the primary side will be released to atmosphere through the valve.

The top actuator was modified with the two ports created on the other side of the cylinder for letting the pressurized air to fire the return stroke. The gas bubble is charged with air at 100 psi and the air is passed through the solenoid valve to the top actuator. Efforts are on to automate the process of firing the component tester once it is set for a particular head impact angle. All the valves and regulators can be controlled using a computer, thereby reducing the errors that could creep in due to manual settings.

The propulsion system for the forward stroke remains same. For the return stroke the compressed air from the air compressor is stored in the gas bubble. The forward stroke is fired by triggering the solenoid operated 5-port valve, which causes the compressed air, set at 60 psi to open the diaphragm valve allowing the accumulator to discharge through the actuator. Then the return stroke is fired by discharging the compressed air at the other end of the actuator through the solenoid and the non-return valve. Due to this the piston is thrown back pulling the support arm with it and thus preventing the secondary impacts.

Further modifications will be done on the top actuator to make it double acting so that it will retract the support arm fully. The project will be completed in December 2002. A series of full-scale sled tests will be done on different bulkhead with different surface treatment and the full-scale sled tests will then be validated with component tester.